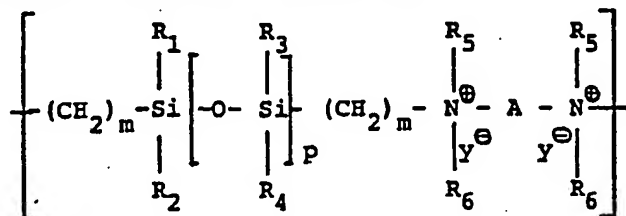


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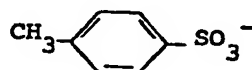
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## (54) Polyquaternary polysiloxane polymers

(57) Quaternary siloxane polymers of the formula:



in which A denotes an  $\alpha,\beta$ -bis-alkylpolysiloxane or a  $\text{C}_{1-6}$  hydrocarbon chain which can contain OH groups and can be interrupted by one or more oxygen atoms and/or aromatic rings;  $\text{R}_1$ ,  $\text{R}_2$ ,  $\text{R}_3$  and  $\text{R}_4$ , which are identical or different, denote a  $\text{C}_1-\text{C}_6$  alkyl or phenyl;  $\text{R}_5$ =methyl, ethyl, hydroxyethyl or  $-\text{CH}_2-$ ;  $\text{R}_6=\text{C}_1-\text{C}_{18}$  alkyl or  $-\text{CH}_2-$ ; if  $\text{R}_5$  and/or  $\text{R}_6$  denote  $-\text{CH}_2-$ , they form a methylpiperazinium radical or ethylpiperazinium radical, a triethylenediamine radical or a heterocycle with  $-\text{N}-\text{A}-\text{N}-$ ; Y denotes one of the anions  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{CH}_3\text{SO}_3^-$ ,



$m=1-6$ ; and  $p=1-50$  are disclosed for use, in particular, for treating the hair, nails and skin. They are resistant to several rinses on these substrates.

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## SPECIFICATION

## Polyquaternary polysiloxane polymers

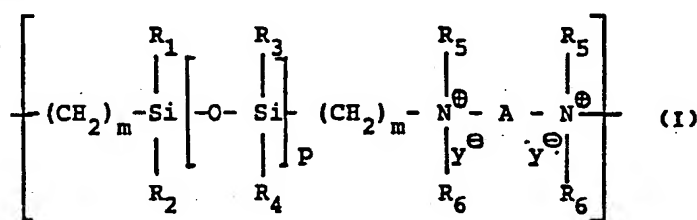
This invention relates to polyquaternary polysiloxane polymers, processes for their preparation and compositions in which they are present, and, in particular, to the use of these compositions in the cosmetics industry, especially for hair care and hair treatments.

It is known to incorporate quaternary polymers into hair-conditioning compositions in order to improve the comb-out and the cosmetic condition of the hair. However, the cosmetic compositions for the hair which contain known quaternary polymers still have disadvantages.

It has been discovered that the polymers of the present invention, when applied to the hair in the form of an aqueous composition, improve the comb-out of the hair, in particular compared with poly-(quaternary ammonium) polymers with a hydrocarbon chain, and leave the hair with little static electricity (which facilitates styling) and in good cosmetic condition.

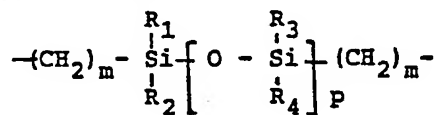
The novelty of the polymers of this invention derives essentially from the position of the ammonium groups and the distribution of the siloxane groups which they contain.

The present invention provides polyquaternary polysiloxane polymers essentially consisting of repeat units of the general formula:



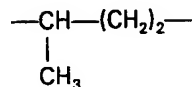
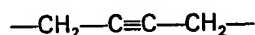
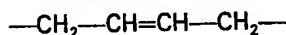
in which:

A denotes a divalent  $\alpha,\omega$ -bis-(alkyl)-polysiloxane group or a linear or branched, saturated or unsaturated hydrocarbon chain containing up to 6 consecutive carbon atoms, which can contain one or more hydroxyl groups and can be interrupted by one or more oxygen atoms and/or one or more aromatic rings; by way of example, A can represent the following groups:



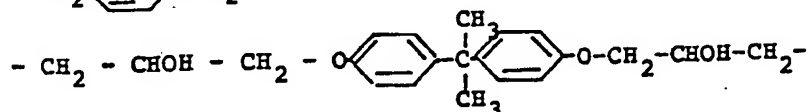
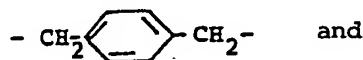
$\text{R}_1, \text{R}_2, \text{R}_3, \text{R}_4, m$  and  $p$  having the meanings below,

$-(\text{CH}_2)_n$ , in which  $n=2$  to 6



$-\text{CH}_2-\text{CHOH}-\text{CH}_2-\text{O}-\text{CH}_2-\text{CHOH}-\text{CH}_2-$

$[\text{CH}_2-\text{CH}_2-\text{O}]_x \text{CH}_2-\text{CH}_2-$ , in which  $x=1$  to 15

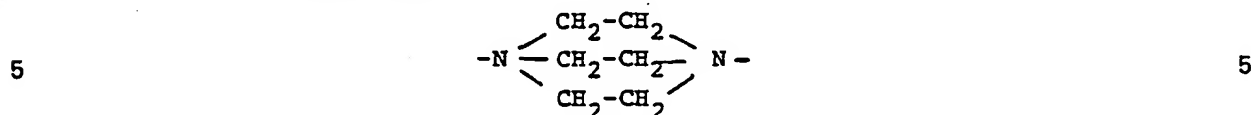


$\text{R}_1, \text{R}_2, \text{R}_3$  and  $\text{R}_4$ , which are identical or different, denote a  $\text{C}_1$ - $\text{C}_6$  alkyl radical or the phenyl radical; the methyl radical is the preferred alkyl radical;

$\text{R}_5$  denotes the methyl, ethyl or hydroxyethyl radical or, alternatively, under the conditions specified below, the divalent radical  $-\text{CH}_2-$ ;

$R_6$  denotes a  $C_{1-18}$  alkyl radical;  $R_6$  can also denote the divalent radical  $-\text{CH}_2-$  (in this case, A denotes  $-\text{CH}_2-\text{CH}_2-$ ) and can form:

- (i) a divalent piperazino group with the two nitrogen atoms and A, or
- (ii) the divalent triethylenediamino radical of the formula:

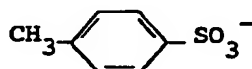


with the two nitrogen atoms, A and  $R_5$  (which in this case denotes  $-\text{CH}_2-$ );

$R_6$  and  $R_5$  can also be joined to one another and can denote a heterocycle, such as piperidino, morpholino or pyrrolidino, with the nitrogen atom to which they are attached;

$Y^\ominus$  denotes one of the anions  $\text{Cl}^\ominus$  or  $\text{Br}^\ominus$  ( $\text{Cl}^\ominus$  and  $\text{Br}^\ominus$  can also be denoted by  $X^\ominus$ ) or the anion

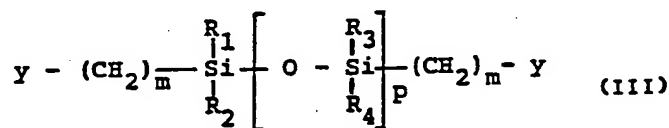
10  $\text{CH}_3\text{SO}_3^\ominus$  or 10



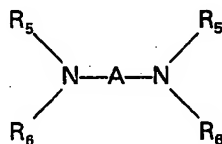
m denotes an integer from 1 to 6 and preferably from 1 to 4; and

p denotes an integer or decimal number from 1 to 50 and preferably 1 to 10; p can represent an integer or a statistical average value in the case of a polymer mixture.

15 The polymers of the formula (I) according to the invention can be prepared by known processes, 15  
for example by reaction of the compound of the formula (III)

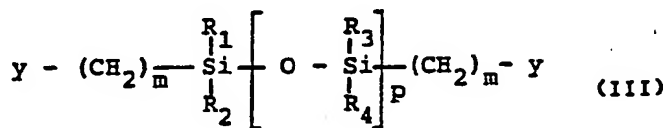


with a bis-tertiary diamine of the formula (IV)



20 In the compounds of the formulae (III) and (IV),  $R_1, R_2, R_3, R_4, R_5, R_6, Y, A, m$  and  $p$  have the 20  
meanings indicated above.

The polysiloxanes of the formula (III)



can be prepared by the known reactions, for example, when  $m=3$ :

25 (1) by reaction of a dialkylchlorosilane with an allyl halide, in the presence of platinum or 25  
chloroplatinic acid used as a catalyst, to give a halogenopropyl-dialkylchlorosilane, which, on  
hydrolysis and condensation, gives the bis-(halogenopropyl)-1,1,3,3-tetraalkyldisiloxane.

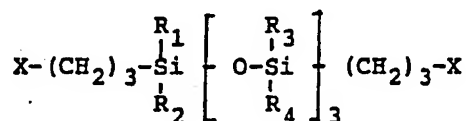
The dialkylchlorosilane can be replaced by a diphenylchlorosilane, by an alkyl-phenylchlorosilane  
or by a mixture of these compounds.

30 (2) by reaction of dialkylchlorosilane, a diphenylchlorosilane or an alkyl-phenylchlorosilane with 30  
allyl acetate, in the presence of platinum or chloroplatinic acid, to give the acetoxypropyl-dialkylchloro-  
silane, which, on hydrolysis and condensation, leads to the 1,3-bis-(3-hydroxypropyl)-1,1,3,3-  
tetraalkyldisiloxane.

35 Halogenation of this compound with a halogenating agent such as phosphorus tribromide,  $\text{PBr}_3$ , 35  
or thionyl chloride,  $\text{SOCl}_2$ , leads to the 1,3-bis-(halogenopropyl)-1,1,3,3-tetramethyldisiloxane.

If a mesyl or tosyl halide is used, a compound of the formula (III) is obtained in which Y denotes  
 $\text{CH}_3\text{SO}_3$  or  $\text{CH}_3-\text{C}_6\text{H}_4-\text{SO}_3$  respectively.

40 The 1,3-bis-(halogenopropyl)-1,1,3,3-tetraalkyldisiloxane can also be obtained directly by 40  
reaction of the 1,1,3,3-tetraalkyldisiloxane with the allyl halide. This reaction also produces a second  
compound, namely 1,1,3,3-tetraalkyl-3-halogenopropyl-1-halogenodisiloxane, which, on hydrolysis,  
makes it possible to obtain the 1,7-bis-(halogenopropyl)-octaalkyltetrasiloxane of the formula:



(3) by reaction of a compound (a), which can be a dialkyldichlorosilane, a diphenyldichlorosilane or an alkyl-phenyldichlorosilane, or a mixture of these compounds, with a compound (b) chosen from:

- 5 (b1) a dialkyl-halogenoalkyl-halogenosilane,  
 (b2) a dialkyl-acetoxyalkyl-halogenosilane,  
 (b3) a dialkyl-acetoxyalkyl-acetoxysilane,  
 (b4) a tetraalkyl-acetoxyalkyl-acetoxydisiloxane,  
 (b5) a dialkyl-halogenoalkyl-methoxysilane or dialkyl-halogenoalkyl-ethoxysilane,  
 (b6) a dialkyl-acetoxyalkyl-methoxysilane or dialkyl-acetoxyalkyl-ethoxysilane,  
 10 (b7) a tetraalkyl-halogenoalkyl-methoxydisiloxane or tetraalkyl-halogenoalkyl-ethoxydisiloxane,

and

- (b8) a tetraalkyl-acetoxyalkyl-methoxydisiloxane or tetraalkyl-acetoxyalkyl-ethoxydisiloxane, this reaction being followed by saponification and then by halogenation of the resulting compound with a halogenating agent such as phosphorus tribromide,  $PBr_3$ , thionyl chloride,  $SOCl_2$ , or a methyl or tosyl halide.

These reactions can be carried out with or without a solvent, if appropriate in the presence of electrolytes, at a temperature of, say, 0 to 120°C. As solvents which can be used, there may be mentioned water, lower alcohols having from 1 to 4 carbon atoms, cyclic ethers such as tetrahydrofuran or dioxane, aliphatic or aromatic hydrocarbons, or mixtures of these solvents.

- 20 The bis-tertiary diamines (IV) which can be used according to the invention are preferably symmetrical amines such as N,N'-tetramethylethylenediamine, N,N'-tetramethylpropylenediamine, N,N'-tetramethylbutylenediamine, N,N'-tetramethylhexamethylenediamine, N,N'-dimethyl-N,N'-dialkyl( $C_1-C_{18}$ )alkylene( $C_2-C_6$ )diamines, 1,4-tetramethyldiaminobut-2-ene, 1,4-tetramethyldiaminobut-2-yne, dihydroxyethylpiperazine, 1,3-bis-(methyl-alkyl( $C_{1-18}$ )amino)-propan-2-ols, 1,3-bis-(methylhydroxyethylamino or ethylhydroxyethylamino)-propan-2-ol and 1,3-bis-(morpholino)-propan-2-ol.

The compounds of the formula (I) can also be obtained, in a second process, by reaction of a bis-tertiary diamine of the formula (V):



- 30 with a bis-halogenated derivative or a bis-mesylated or bis-tosylated derivative of the formula (VI):



A,  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$ ,  $R_5$ ,  $R_6$ , Y, m and p having the meanings indicated above.

The diamino compounds of the formula (V) can be obtained by reaction of the difunctional derivatives (III) with the corresponding secondary amines



or alternatively, when  $m=3$ , by reaction of the dihydropolysiloxane derivative with the substituted allylamine.

- Examples which may be mentioned of the difunctional derivatives (VI) are the compounds (III), alkyl or xylal dihalides, the bis-chlorohydrin of glycerol or diglycerol, the bis-3-chloro-2-hydroxypropyl ether of bisphenol A, and  $\alpha,\omega$ -halogenated,  $\alpha,\omega$ -mesylated or  $\alpha,\omega$ -tosylated derivatives of ethylene or polyethylene glycol.

- The polyquaternary polysiloxane polymers of the formula (I) according to the invention can be obtained by heating the compounds of the formulae (III) and (IV) or the compounds of the formulae (V) and (VI) in water or in various solvents such as alcohols having from 2 to 4 carbon atoms, glycols, glycol ethers, aliphatic or aromatic hydrocarbons, ketones such as methyl ethyl ketone or methyl isobutyl ketone, or mixtures thereof, at temperatures of, say, 80 to 150°C, if appropriate under pressure.

The polyquaternary polysiloxane polymers obtained after polymerisation usually have a molecular weight of 500 to 50,000.

The polymers according to the invention are soluble or dispersible in water or in an aqueous-alcoholic medium and are preferably used at a concentration of 0.1 to 10% and more advantageously of 0.2 to 5%, by weight, by themselves or in combination with one or more cosmetic adjuvants, in cosmetic compositions for treating the hair, nails or skin.

5 In aqueous solution, these polymers have a good affinity for keratin fibres, on which they form a rinse-resistant deposit. 5

If the cosmetic compositions containing the polymers according to the invention are applied to the hair, they make the hair easier to comb out and shape, while at the same time imparting softness and shine and leaving the hair with little static electricity, which also facilitates styling. Furthermore, 10 the polymers according to the invention are rather mild towards the skin or the mucous membrane of the eye. 10

This invention also provides cosmetic compositions containing at least one polyquaternary polysiloxane polymer for treating the hair, nails and skin, and more particularly for hair care.

The cosmetic compositions can be applied to the hair as pretreatments, facilitating the 15 subsequent fixing of anionic active substances, for example, or as post-treatments, such as lotions, rinse-off lotions or styling gels, or they can constitute the main treatment in the form of a shampoo, setting lotion or dye. 15

The cosmetic compositions according to the invention can be aqueous, aqueous-alcoholic or solvent-based and, if appropriate, can contain oils; they can be presented in the form of solutions, 20 lotions, creams, dispersions, gels or aerosols, for example. 20

In addition to the polymer essentially consisting of units corresponding to the formula (I), the cosmetic compositions according to the invention can contain any component used in cosmetic compositions, in particular anionic, cationic, amphoteric, zwitterionic or non-ionic surface-active agents, foam synergistic agents, foam stabilisers, opacifiers, sequestering agents, thickeners, 25 emulsifying agents, softeners, preservatives, protein derivatives, natural substances, colorants, perfumes and anionic, cationic, amphoteric and non-ionic polymers. 25

This invention thus provides cosmetic compositions for treating the hair which contain at least one polyquaternary polysiloxane polymer of the formula (I) and at least one anionic polymer, if appropriate in the presence of another cationic compound; these compositions can contain other 30 adjuvants normally used in cosmetics. 30

When the compositions according to the invention constitute shampoos, they are generally in the form of aqueous solutions and comprise, in addition to the polymer consisting of units of the formula (I), at least one anionic, cationic, non-ionic or amphoteric detergent.

In these shampoos, the concentration of detergent is generally from 1 to 50% and preferably from 35 1 to 30%, by weight, relative to the total weight of the composition, and the pH is generally from 3 to 9. 35

The compositions in the form of shampoos also generally contain various adjuvants, in particular perfumes, preservatives, thickeners, foam stabilisers and colorants. The proportion of these adjuvants, expressed in % by weight of the total weight of the composition, is generally 0.5 to 10% for the foam 40 stabilisers, 0.1 to 5% for the thickeners, and 0.01 to 3% for each of the perfumes, colorants and preservatives. 40

When the compositions according to the invention constitute lotions, they are usually aqueous or aqueous-alcoholic solutions containing a lower alkanol having from 1 to 4 carbon atoms, and preferably ethanol or isopropanol in an amount of 5 to 70%, and, if appropriate, other cosmetic 45 polymers and/or surface-active agents. 45

The compositions according to the invention can also constitute treatment creams in the form of an emulsion containing the polymer consisting of units of the formula (I). These creams can also contain colorants, in particular oxidation dyestuffs and/or direct dyestuffs, and can constitute dyeing creams or colouring creams.

50 The compositions according to the invention can also be used in a reducing or oxidising solution for perming, in order to curl the hair. 50

The cosmetic compositions according to the invention generally have a pH of 3 to 12 and preferably 3.5 to 8.5.

If the compositions are packaged in the form of aerosols, they contain a propellant gas. 55 This invention also provides a process for treating the hair, nails or skin, essentially characterised in that a composition as defined above is applied to the hair, nails or skin in a sufficient amount to condition the hair, nails or skin. 55

This invention is further illustrated by the following Examples.

#### Preparation Examples

60 Example 1 60

Preparation of a mixture of compounds of the formula (I) in which  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$ ,  $R_5$  and  $R_6$  denote  $CH_3$ ,  $m=3$ ,  $p=1$ ,  $Y=Br$ ,  $A=(CH_2)_3$

182.5 g (1.93 mol) of dimethylchlorosilane and 1.4 g of 5% strength platinum-on-charcoal are introduced into a one litre reactor fitted with a stirrer, a thermometer and a reflux condenser.

242 g (2.42 mol) of allyl acetate are added to this dispersion over a period of 10 minutes, with stirring, and the reaction mixture is then heated for 20 hours under reflux. The catalyst is removed by filtration and the mixture is then topped under a reduced pressure of 50 mm Hg (6.66 kPa).

233 g of dimethyl-acetoxypropylchlorosilane are then distilled under a pressure of 0.1 mm Hg (13.33 Pa) and at a temperature of 53—55°C.

194.5 g of the product thus obtained are dissolved in one litre of 96° strength ethanol. The solution is cooled in an ice bath and 200 g of a 40% strength aqueous solution of NaOH are added over a period of 20 minutes. The reaction mixture is then heated under reflux for 1 hour. The inorganic salts formed are removed by filtration.

After partial concentration, extraction is carried out twice with 250 ml of chloroform and the extracts are then washed with twice 100 ml of water. The organic phase is dried over anhydrous sodium sulphate and the solvent is removed by evaporation.

This gives 116 g of 1,3-bis-(3-hydroxypropyl)-1,1,3,3-tetramethyldisiloxane: compound A.

200 g (0.7 mol) of  $\text{PBr}_3$  and 65 ml of dichloroethane are introduced into a one litre reactor and the mixture is cooled in an ice bath. A solution of 200 g (0.8 mol) of the previously obtained compound A in 200 ml of methylene chloride is then added over a period of 15 minutes.

The mixture is stirred for a further one hour in an ice bath, then heated for one hour at 50°C and then left to stand overnight at ambient temperature.

The solution is subsequently washed with 250 ml of water and then twice with 250 ml of a saturated solution of sodium bicarbonate. The organic phase is dried over anhydrous sodium sulphate and the solvent is removed by evaporation.

Distillation at 102°C under a pressure of 0.01 mm Hg (1.33 Pa) gives 125 g of 1,3-bis-(bromopropyl)-1,1,3,3-tetramethyldisiloxane (compound  $\text{III}_1$ ).

32.7 g (0.25 mol) of N,N'-tetramethyl-1,3-propylenediamine and 37.5 g of water are mixed in a 250 cc reactor. This solution is heated to the reflux temperature and 94 g (0.25 mol) of the compound  $\text{III}_1$ , described above are added over a period of 30 minutes. The reaction medium is thus heated for 13 hours.

This gives a resin which, in the anhydrous state, is almost colourless and soft. It is soluble in water. Its intrinsic viscosity, measured in water at 25°C, is 0.044 dl/g.

### 30 Example 2

Preparation of a mixture of compounds of the general formula (I) in which  $\text{R}_1, \text{R}_2, \text{R}_3, \text{R}_4, \text{R}_5$  and  $\text{R}_6$  denote  $\text{CH}_3$ ,  $m=3$ ,  $p=3$ ,  $\text{Y}=\text{Cl}$ ,  $\text{A}=(\text{CH}_2)_3$

93.7 g (0.7 mol) of 1,1,3,3-tetramethyldisiloxane, 160 g (2.1 mol) of freshly distilled allyl chloride and 0.47 g of a 5% strength platinum-on-charcoal catalyst are introduced into a one litre autoclave.

The mixture is heated for 12 hours at 120°C. The catalyst is removed by filtration and the excess allyl chloride is evaporated off under reduced pressure. The residue is then distilled under 9 mm Hg (1,200 Pa).

47.3 g of 1-chloro-3-chloropropyl-1,1,3,3-tetramethyldisiloxane are thus collected at 80—82°C.

46.3 g of the above compound are run into 100 ml of a saturated solution of sodium chloride over a period of 5 minutes. The mixture is stirred for 40 minutes at 45°C and then for 40 minutes at ambient temperature and a further 15 minutes at 45°C. The sodium chloride is filtered off and the filtrate is extracted with ether.

After the ether phase has been dried over anhydrous sodium sulphate and the solvent removed by evaporation, the residue is distilled under a pressure of 0.01 mm Hg (1.33 Pa). 21 g of 1,7-bis-(chloropropyl)-1,1,3,3,5,5,7,7-octamethyltetrasiloxane are collected at 113—116°C.

15.8 g of the difunctional compound prepared in this way (0.036 mol) are solubilised with 4.75 g (0.036 mol) of N,N'-tetramethyl-1,3-propylenediamine in 40 ml of dimethylformamide. The mixture is heated for 20 hours at 125°C and the polymer is then precipitated in 100 ml of ether.

A soft water-soluble resin having a chloride content of 3.87 meq/g is thus isolated.

### 50 Example 3

Preparation of a mixture of compounds of the general formula I in which  $\text{R}_1, \text{R}_2, \text{R}_3, \text{R}_4, \text{R}_5$  and  $\text{R}_6$  denote  $\text{CH}_3$ ,  $m=1$ ,  $p=1$ ,  $\text{Y}=\text{Br}$ ,  $\text{A}=(\text{CH}_2)_3$

1,3-Bis-(bromomethyl)-1,1,3,3-tetramethyldisiloxane is prepared by brominating trimethylchlorosilane with phosphorus tribromide, the resulting compound undergoing condensation on hydrolysis with water.

23.6 g (0.074 mol) of the compound prepared in this way are solubilised with 9.6 g (0.074 mol) of N,N'-tetramethylpropylenediamine in 100 ml of methyl isobutyl ketone. The mixture is heated under reflux for 10 hours. The precipitated polymer is washed with ether and dried.

25.7 g of a clear, very hygroscopic, water-soluble resin are isolated. Its absolute viscosity, at a concentration of 5% in water at 25°C, is 0.96 cps.

**Example 4**

**Preparation of a mixture of compounds of the general formula (I) in which  $R_1, R_2, R_3, R_4, R_5$  and  $R_6$  denote  $CH_3$ ,  $m=3$ ,  $p=1$ ,  $A=(CH_2)_4$ ,  $Y=Br$**

- 42.5 g (0.5 mol) of dimethylallylamine and 33.5 g (0.25 mol) of tetramethyldisiloxane are mixed, together with 0.34 g of 5% strength platinum-on-charcoal, in a 250 ml autoclave. The mixture is heated for 5 hours at 120°C. After the catalyst has been filtered off, the volatile compounds are removed by distillation under 50 mm Hg (6.66 kPa). The residue is subjected to distillation under 0.01 mm Hg (1.33 Pa) and 40 g of 1,3-bis-(3-dimethylaminopropyl)-tetramethyldisiloxane are isolated at 80—82°C.
- 10 g (0.033 mol) of 1,3-bis-(3-dimethylaminopropyl)-tetramethyldisiloxane and 4 ml of water are introduced into a reactor fitted with a stirrer, a thermometer and a reflux condenser. 6.97 g of 1,4-dibromobutane are added rapidly to this solution and the mixture is then heated at 90—95°C for 1 hour 45 minutes. This gives a solution of polymer having a bromide content of 3.1 meq/g.

**Example 5**

- Preparation of a mixture of compounds of the formula (I) in which  $R_1, R_2, R_3, R_4$  and  $R_5$  denote  $CH_3$ ,  $R_6$  denotes  $C_{12}H_{25}$ ,  $Y=Br$ ,  $A=(CH_2)_6$ ,  $p=6$ ,  $m=3$**

- A mixture of 129 g (1 mol) of dimethyldichlorosilane and 77.9 g (0.4 mol) of dimethyl-acetoxypentylchlorosilane is added, at between 20 and 25°C, to 500 ml of water saturated with sodium chloride. The mixture is stirred for 4 hours at this temperature. The sodium chloride is removed by filtration and then washed with twice 50 ml of methylene chloride. The filtrate is decanted and the aqueous phase is washed with twice 150 ml of methylene chloride. The organic phases are combined and then washed with 100 ml of a saturated solution of sodium bicarbonate. The organic phase is dried over anhydrous sodium sulphate.

- After the solvent has been removed, 128.3 g of a colourless oil are collected, that is to say a yield of 96%.

- This oil is dissolved in 700 ml of ethanol. 140 g (1.4 mol) of a 40% strength aqueous solution of NaOH are added to this solution, at between 20 and 25°C, and the mixture is then stirred for 1 hour at this temperature. 700 ml of water are then added and the greater part of the ethanol is removed by evaporation in vacuo. The medium is neutralised by adding 230 ml of 6 N HCl. The medium is extracted with 3 times 200 ml of chloroform. The organic phase is washed with 100 ml of water and dried over anhydrous sodium sulphate.

- After evaporation to dryness, 100.4 g of a colourless oil are isolated, that is to say a yield of 90.3%.

- All the above oil is dissolved in 60 ml of methylene chloride.
- A solution of 27 g of  $PBr_3$  in 140 ml of methylene chloride is added to this solution over a period of 1 hour 30 minutes at 5°C. Stirring is continued for 1 hour at ambient temperature and the mixture is then heated at the reflux temperature of the solvent for 3 hours.

- The organic phase is washed with 100 ml of a saturated solution of sodium bicarbonate and then with three times 100 ml of water.

- It is dried over sodium sulphate and the solvent is then removed by distillation under a pressure of 800 Pa. 81 g of a very slightly coloured oil having a bromine content of 2.45 meq/g are thus collected (compound A).

- A solution of 13.2 g (0.016 mol) of the compound A in 15 g of methylcellosolve is added to a solution of 7.7 g (0.016 mol) of 1,6-bis-(methylaurilamino)-hexane in 5 g of methylcellosolve.

- The mixture is heated for 6 hours at 105°C and the solvent is then removed under reduced pressure (800 Pa).

- 20.1 g of a viscous oil soluble in 95° strength ethanol having a bromide content of 1.30 meq/g are collected.

**Example 6**

- Preparation of a mixture of the compound of the formula (I) in which  $R_1, R_2, R_3, R_4$  and  $R_5$  denote  $CH_3$ ,  $R_6=C_8H_{17}$ ,  $Y=Br$ ,  $A=CH_2-CHOH-CH_2-$ ,  $p=6$ ,  $m=3$**

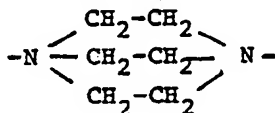
- A solution of 13.2 g (0.016 mol) of the compound A, prepared according to Example 5, in 15 g of methylcellosolve (ethylene glycol monomethyl ether) is added to a solution of 5.5 g (0.016 mol) of 1,3-bis-(methyloctylamino)-propan-2-ol in 5 g of methylcellosolve.

- The mixture is heated for 10 hours at 105°C. The solvent is removed by distillation under a reduced pressure of 800 Pa.

- 17.3 g of a very thick oil soluble in 95° strength ethanol and having a bromide content of 1.35 meq/g are thus isolated.

**Example 7**

Preparation of a mixture of compounds of the formula (I) in which  $R_1, R_2, R_3$  and  $R_4$  denote  $\text{CH}_3$ , the unit formed by  $R_5, R_6, A$  and the two nitrogen atoms denotes the triethylenediamino radical of the formula:



$\text{Y}=\text{Br}, p=6, m=3$

A solution of 13.2 g (0.016 mol) of the compound A, prepared according to Example 5, in 15 g of methylcellosolve is added to a solution of 1.80 g (0.016 mol) of 2,2,2-diazabicyclooctane in 5 g of methylcellosolve. The mixture is heated for 6 hours at  $105^\circ\text{C}$ . The solvent is removed by distillation under 800 Pa. 13.1 g of a thick translucent paste soluble in  $95^\circ$  strength ethanol and having a bromide content of 2.08 meq/g are isolated.

**Example 8**

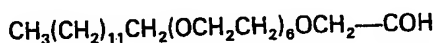
Preparation of a mixture of compounds of the formula (I) in which  $R_1, R_2, R_3, R_4$  and  $R_5$  denote  $\text{CH}_3, R_6$  and A from a piperazine ring with the two nitrogen atoms,  $\text{Y}=\text{Br}, p=6, m=3$

A solution of 13.2 g (0.016 mol) of the compound A, prepared according to Example 5, in 15 g of methylcellosolve is added to a solution of 1.82 g (0.016 mol) of N,N'-dimethylpiperazine in 5 g of methylcellosolve. The reaction mixture is heated for 15 hours at  $105^\circ\text{C}$ . The solvent is evaporated off under a reduced pressure of 800 Pa. 14.5 g of a thick paste soluble in  $95^\circ$  strength alcohol and having a bromide content of 1.78 meq/g are isolated.

**Application Examples****Example A1**

The following shampoo is prepared:

Compound prepared according to Example 1	1 g A.I. <sup>(1)</sup>	
Glucoside alkyl ether containing 30% of active ingredient, sold under the name "TRITON CG 110" by SEPPIC	18 g	25
Compound of the formula		



sold under the name "Sandopan M acid" by SANDOZ	3 g	
NaOH q.s. pH 7.5		
Perfume, colorant, preservative, q.s.		30
Water q.s. (quantity sufficient for)	100 g	

<sup>(1)</sup> A.I.=active ingredient.

**Example A2**

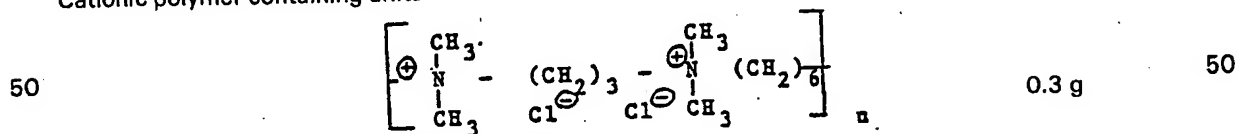
The following after-shampoo is prepared:

Compound prepared according to Example 3	0.5 g A.I.	35
Mixture of cetyl-stearyl alcohol and cetyl-stearyl alcohol oxyethyleneated with 15 mol of ethylene oxide per mol of alcohol, sold under the name "SINNOWAX A O" by HENKEL	2 g	
Cetyl alcohol	4 g	
Hydroxymethylcellulose sold under the name "CELLOSIZE QP 4400 H" by UNION CARBIDE	5 g	40
HCl q.s. pH 7		
Perfume, preservative, colorant q.s.	100 g	
Water q.s.		

**Example A3**

A rinse-off lotion having the following composition is prepared:

Compound prepared according to Example 1	1 g A.I.	
Distearyldimethylammonium chloride	1 g	
Cationic polymer containing units		



prepared according to French Patent 2,270,846



NaOH q.s. pH 7.3  
 Perfume, colorant, preservative q.s.  
 Water q.s. 100 g

**Example A4**

5 The non-ionic shampoo having the following composition is prepared: 5

Compound of Example 5 0.8 g  
 Polyglycerol hydroxyalkyl ether of the formula:



R representing a mixture of alkyl radicals having 9 to 12 carbon atoms 7 g  
 10 Diethanolamines of copra fatty acids 3 g 10  
 Water q.s. 100 g  
 pH adjusted to 7.3

**Example A5**

The following setting lotion is prepared:

15 Compound of Example 6 0.5 g 15  
 Vinylpyrrolidone/vinyl acetate copolymer (60/40) 2 g  
 95° strength ethanol 15 g  
 Water q.s. 100 g  
 pH adjusted to 7.4

20 **Example A6** 20  
 The following after-shampoo is prepared:

Compound of Example 7 0.5 g  
 Compound of Example 8 0.2 g  
 25 Mixture of cetyl-stearyl alcohol and cetyl-stearyl alcohol oxyethyleneated  
 with 15 mol of ethylene oxide, sold under the name 25  
 "SINNOWAX A O" by HENKEL 2 g  
 Cetyl alcohol 4 g  
 Hydroxymethylcellulose sold under the name "Cellosize QP 4400H" by  
 Union Carbide 5 g  
 30 Water q.s. 100 g 30  
 pH adjusted to 7

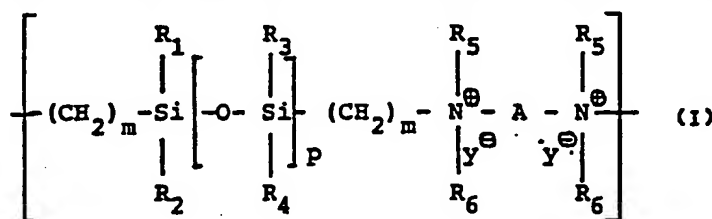
**Example A7**

The following rinse-off lotion is prepared:

Compound of Example 8 1.2 g  
 35 Dimethyldistearylammonium chloride 0.8 g 35  
 Quaternary polyvinylpyrrolidone copolymer having a molecular weight of 1  
 million, sold under the name Gafquat 755 by General Aniline 1 g  
 95° strength ethanol 20 g  
 Water q.s. 100 g  
 40 pH adjusted to 7.2 40

**Claims**

1. A polyquaternary polysiloxane polymer which comprises recurring units of the general formula:



in which:

45 A denotes a divalent  $\alpha,\omega$ -bis-(alkyl)-polysiloxane group or a linear or branched, saturated or 45

unsaturated hydrocarbon chain containing up to 6 consecutive carbon atoms, optionally substituted by one or more hydroxyl groups and optionally one or more chain oxygen atoms and/or aromatic rings;

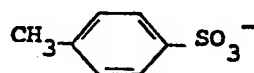
$R_1, R_2, R_3$  and  $R_4$ , which are identical or different, denote a  $C_1-C_6$  alkyl radical or a phenyl radical;

$R_5$  denotes a methyl, ethyl or hydroxyethyl radical;

5  $R_6$  denotes a  $C_1-C_{18}$  alkyl radical or two adjacent radicals  $R_6$  together with the nitrogen atom to which they are attached and the radical A therebetween form a divalent piperazino group;

or two adjacent radicals  $R_5$  together with the two radicals  $R_6$  attached to the same nitrogen atoms, the said nitrogen atoms and the radical A therebetween form a triethylenediamino radical, or  $R_5$  and  $R_6$  together denote a heterocycle with the nitrogen atom to which they are attached;

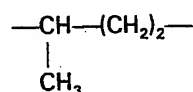
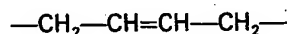
10  $Y^-$  denotes an anion which is  $Cl^-$ ,  $Br^-$ ,  $CH_3SO_3^-$  or



m denotes an integer from 1 to 6; and

p denotes a number from 1 to 50.

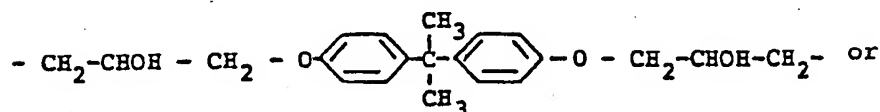
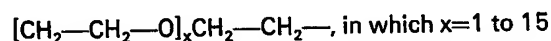
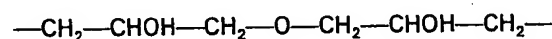
2. A polymer according to claim 1, in which  $R_1, R_2, R_3$  and  $R_4$  denote  $CH_3$ , m denotes an integer from 1 to 4, p denotes a number from 1 to 10 and A is  $-(CH_2)_n-$ , in which n denotes an integer from 2 to 6,



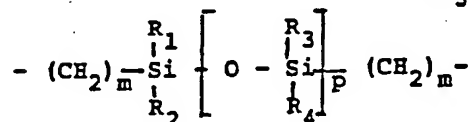
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$R_1, R_2, R_3, R_4, m$  and  $p$  being as defined in claim 1.

3. A polymer according to claim 2 in which A is  $-(CH_2)_n-$  in which n denotes 3, 4 or 6 or  $-CH_2-CHOH-CH_2-$ .

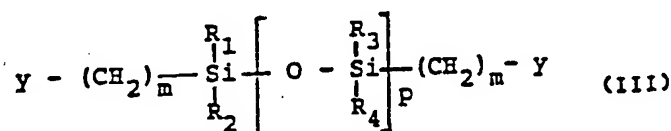
4. A polymer according to claim 1 in which two adjacent radicals  $R_5$  together with the radicals  $R_6$  attached to the same nitrogen atoms, the said nitrogen atoms and the radical A therebetween form a triethylenediamino radical.

5. A polymer according to any one of claims 1 to 3 in which  $R_6$  represents methyl, octyl or dodecyl or two radicals  $R_6$  and A together with the nitrogen atoms connected thereto form a divalent piperazino ring.

6. A polymer according to any one of the preceding claims in which  $Y^-$  denotes  $Cl^-$  or  $Br^-$ .

7. A polymer according to claim 1 specifically identified herein.

8. Process for the preparation of a polymer as claimed in any one of the preceding claims which comprises reacting a siloxane of the formula:



in which  $R_1, R_2, R_3, R_4, Y, p$  and  $m$  are as defined in claim 1, with a bis-tertiarydiamine of the formula:



in which  $R_5, R_6$  and  $A$  are as defined in claim 1, by heating in a solvent at a temperature of 80 to 150°C.

9. Process according to claim 8 in which the compound of the formula IV is N,N'-tetramethylethylenediamine, N,N'-tetramethylpropylenediamine, N,N'-tetramethylbutylenediamine, N,N'-tetramethylhexamethylenediamine, N,N'-dimethyl-N,N'-dialkyl( $C_1-C_{18}$ )alkylene( $C_2-C_6$ )diamines, 1,4-tetramethyldiaminobut-2-ene, 1,4-tetramethyldiaminobut-2-yne, dihydroxyethylpiperazine, 1,3-bis-(methyl-alkyl( $C_1-C_{18}$ )amino)-propan-2-ols, 1,3-bis-(methylhydroxyethylamino or ethylhydroxyethylamino)-propan-2-ol and 1,3-bis-(morpholino)-propan-2-ol.

10. Process according to claim 8 or 9 in which the siloxane of formula III is prepared:

(1) by reaction of a dialkylchlorosilane, a diphenylchlorosilane or an alkyl-phenylchlorosilane, or a mixture of these compounds, with an allyl halide, in the presence of a platinum or chloroplatinic acid catalyst, and hydrolyzing and condensing the resulting compound to give the bis-halogenopropyl-1,1,3,3-tetraalkyldisiloxane and/or the bis-halogenopropyl-1,1,3,3-tetraphenyldisiloxane; or

(2) by reaction of a dialkylchlorosilane and/or a diphenylchlorosilane with allyl acetate, in the presence of a platinum or chloroplatinic acid catalyst, to give acetoxypropyl-dialkylchlorosilane and/or the acetoxypropyl-diphenylchlorosilane, hydrolyzing this product to give 1,3-bis-(3-hydroxypropyl)-1,1,3,3-tetraalkyldisiloxane and/or 1,3-bis-(3-hydroxypropyl)-1,1,3,3-tetraphenyldisiloxane, and halogenating this product to give the 1,3-bis-(halogenopropyl)-1,1,3,3-tetraalkyldisiloxane and/or the 1,3-bis-(halogenopropyl)-1,1,3,3-tetraphenyldisiloxane; or

(3) by reaction of a compound (a) which is a dialkyldichlorosilane, a diphenyldichlorosilane or an alkylphenyldichlorosilane, or a mixture of these compounds, with a compound (b) which is:

(b1) a dialkyl-halogenoalkyl-halogenosilane,

(b2) a dialkyl-acetoxyalkyl-halogenosilane,

(b3) a dialkyl-acetoxyalkyl-acetoxysilane,

(b4) a tetraalkyl-acetoxyalkyl-acetoxydisiloxane,

(b5) a dialkyl-halogenoalkyl-methoxysilane or dialkyl-halogenoalkyl-ethoxysilane,

(b6) a dialkyl-acetoxyalkyl-methoxysilane or dialkyl-acetoxyalkyl-ethoxysilane,

(b7) a tetraalkyl-halogenoalkyl-methoxydisiloxane or tetraalkyl-halogenoalkyl-ethoxydisiloxane, or

(b8) a tetraalkyl-acetoxyalkyl-methoxydisiloxane or tetraalkyl-acetoxyalkyl-ethoxydisiloxane.

11. Process for the preparation of a polymer as claimed in any one of claims 1 to 7 which comprises reacting a bis-tertiary diamine of the formula:



- with a bis-halogenated, bis-mesylated or bis-tosylated derivative of the formula:



$R_1, R_2, R_3, R_4, R_5, R_6, m, p, Y$  and  $A$  being as defined in claim 1, by heating in water or in a lower alcohol, glycol, glycol ether, aliphatic hydrocarbon, aromatic hydrocarbon, ketone or mixture thereof, at a temperature of 80 to 150°C, optionally under pressure.

12. Process according to claim 8 or 11 substantially as described in any one of Preparation Examples 1 to 8.

13. A polymer as defined in claim 1 whenever prepared by a process as claimed in any one of claims 8 to 12.

14. A composition suitable for treating the hair, nails or skin which comprises an effective amount of at least one polymer as claimed in any one of claims 1 to 7 and 13 and a diluent or carrier.

15. A composition according to claim 14 which is in the form of a shampoo and contains at least one anionic, cationic, non-ionic, amphoteric or zwitterionic surface-active agent.

16. A composition according to claim 14 which is in the form of a dyeing composition and contains one or more dyestuffs.

17. A composition according to any one of claims 14 to 16 which contains at least one anionic polymer.

18. A composition according to any one of claims 14 to 17 which contains at least one anionic, cationic, amphoteric, zwitterionic and non-ionic surface-active agent, foam synergistic agent, foam

stabilizer, opacifier, sequestering agent, thickener, emulsifier, softener, preservative, protein derivative, natural substance, colorant, perfume, or anionic, cationic amphoteric or non-ionic polymer.

19. A composition according to claim 14 substantially as described in any one of Application Examples A1 to A7.

5 20. Process for treating the hair, nails or skin, which comprises applying thereto a composition as claimed in any one of claims 14 to 19 in a sufficient amount to condition the hair, nails or skin. 5

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